

II. REMARKS

Claims 1-19 are pending. The Examiner has allowed claims 2-3, and the Applicant's attorney, Mr. Bryan Santarelli, has amended claims 1, 8, 11, 16, 17, and 19. The Applicant's attorney and the inventor's supervisor and assignee representative, Mr. Tom Hopkins, thank the Examiner for conferencing with them at the end of August 2005. Furthermore, even though this response is to a final Office Action, the Applicant's attorney requests the Examiner to phone him to discuss the claims if, after considering this response, the Examiner does not allow all of the claims. The Applicant's attorney regrets that he was unable to file a response after the conference and before October 21, 2005 (the mailing date of the final Office Action), but reminds the Examiner that this was because he was out of the office for almost a month during that time.

Rejection of Claims 1 and 4-19 Under 35 U.S.C. § 103(a) As Being Unpatentable Over Prior Art FIG. 2 Of the Patent Application in view of U.S. Patents 6,218,750 and 6,675,656 to Nakagawa and Sondermeyer

As discussed below, the Applicant's attorney disagrees with, and thus requests withdrawal of, this rejection.

Claim 1

Claim 1 as amended recites an electrical network operable to generate a back EMF signal that represents a back EMF voltage induced in an electrically floating coil of a brushless DC motor. The network generates the back EMF signal by removing a predetermined offset voltage from a voltage received from the floating coil if the predetermined offset voltage is of a same order of magnitude as the back EMF voltage.

For example, referring, e.g., to FIGS. 4-5 and the corresponding text of the patent application, while a coil A of a sensorless, brushless DC motor is floating, an electrical offset network 50a generates a back EMF signal E_a that represents a back EMF voltage e_a induced in the floating coil A by removing a predetermined offset voltage (equal to $\frac{1}{2}$ of the forward voltage across the diode Dgb) from a coil tap voltage V_a . The offset network 50a

removes the predetermined offset voltage because in certain applications of the motor, the offset voltage is on the same order of magnitude as e_a . For example, the predetermined offset voltage is approximately 0.3 volts, which is about $\frac{1}{2}$ of a diode forward voltage, and e_a , which may be sinusoidal, may have an amplitude of between 0.5 – 10 volts. By removing the offset voltage, the network 50a allows the zero-crossing detector 52a to more accurately detect the zero crossing of the back EMF voltage e_a . Because the motor uses the zero crossing of e_a to commutate the motor phases, a more accurate detection of e_a 's zero crossing allows better commutation (e.g., less jitter).

In contrast, the combination of the application's FIG. 2, Nakagawa, and Sondermeyer would not have motivated one to develop a network for generating a back EMF signal representing a back EMF voltage by removing a predetermined offset voltage from a tap voltage of a floating brushless-motor coil if the predetermined offset voltage is of a same order of magnitude as the back EMF voltage.

As discussed with the Examiner, the following is a summary of the inventor's development of the circuit recited in claim 1.

In the prior art, brushless DC motors were used in applications where the back EMF voltage induced in a floating coil was relatively high, typically on the order of 30 volts or more. This relatively high back EMF voltage resulted from the relatively high motor speed, typically greater than 1000 rpm, that these applications required. Examples of such applications include fan and disk-drive motors.

Consequently, because the back EMF voltage was one or more orders of magnitude higher than the offset voltage introduced by the diodes D_g (FIG. 2), this offset voltage introduced negligible error into the zero-crossing determination, and thus went unnoticed by engineers.

A customer of the assignee, however, asked the inventor to develop a circuit for controlling a brushless DC motor in an automatic seed dispenser, where the motor would operated at a relatively low speed of less than 100 rpm.

The first version of the circuit that the inventor developed for the customer used circuitry similar to the prior-art circuitry of FIG. 2 for commutating the coil drive currents in

response to the zero crossings of the back EMF voltages induced in the floating motor coils.

But the inventor discovered that the timing with which this first circuit version commutated the coil drive currents at the desired low speed was out of phase with the rotor position.

Subsequently, after studying the problem, the inventor discovered that a voltage offset introduced into the zero-crossing measurement was causing the timing error in the commutation, and that the diodes Dg were the main source of this voltage offset. The inventor solved this problem by modifying the circuit to account for this offset. For example, the network recited in claim 1 accounts for this offset by reducing or eliminating the offset's contribution to the measurement of the back EMF voltage.

Consequently, to make a *prima facie* case of obviousness, the Examiner must show that the combination of the cited references would have motivated one of skill in the art to both realize the cause of the above-described commutation-timing problem and to solve the problem using the circuit recited in claim 1.

The Applicant's attorney believes that the cited references do not make a *prima facie* case of obviousness because, as discussed below they do not suggest the cause of the above-described commutation-timing problem; and even if these references do suggest the cause, one attempting to solve the commutation-timing problem would not have been motivated to look at them for a solution. It seems that the Examiner is improperly imputing to one of ordinary skill in the art the knowledge that the commutation-timing problem was being caused by the offset voltages introduced by the diodes Dg, and is stating that in view of this knowledge, the cited references would have made *prima facie* obvious the claimed solution of reducing or eliminating this diode offset from the measured voltage. But imputing the cause of the problem to one of ordinary skill is improper; the Examiner may impute only the knowledge of the problem, not its cause, to one of ordinary skill. Consequently, to make claim 1 *prima facie* obvious, the cited references must suggest the cause of the problem as well as the claimed solution. Put another way, the Examiner seems to be using hindsight by stating that once the cause (offset voltage from diodes) of the commutation-timing problem was known, the solution was obvious. But the Examiner

fails to realize that such hindsight is improper because a significant portion of the inventive effort here was identifying the cause of the problem.

Referring now to the cited references, although FIG. 2 discloses a drive circuit for a sensorless, brushless motor, it neither discloses nor suggests the cause of the above-described commutation-timing problem, let alone a solution to the problem. For years, engineers had been using circuits similar or identical to that shown in FIG. 2 with the zero-crossing technique for high-speed applications without the above-described commutation-timing problem, so the circuit of FIG. 2 had never been recognized as causing a commutation-timing problem. Furthermore, the circuit itself does not disclose or suggest that offset voltages are introduced into the center-tap voltages V_n , nor does it disclose or suggest that the diodes D_g are the sources of these offset voltages. And even if FIG. 2 does suggest that the voltages V_n include offset voltages and that the diodes D_g are the sources of these offset voltages, FIG. 2 does not suggest that these offset voltages would cause the above-described commutation-timing problem.

Furthermore, because Nakagawa discloses only a sensor-type brushless motor, one would not have been motivated to look to the teachings of Nakagawa for the cause of the above-described commutation-timing problem. Generally, there are two different techniques for commutating the phases of a brushless motor. The sensor-based technique uses dedicated external sensors to sense the position of the motor, and the sensorless technique (the one corresponding to claim 1) senses the zero crossings of the back EMF voltages in the motor coils when they are electrically floating. Because the zero crossings correspond to known motor positions, the sensorless technique effectively uses the motor coils as position sensors, and thus allows elimination of external sensors and their associated circuitry. Nakagawa discloses a sensor-based technique for a sensor-type motor. Specifically, referring to FIG. 7, Nakagawa discloses magnetoresistance-effect elements (sensors) 20a-20c for detecting the motor position, which the control means 34 uses to commutate the motor. Because the sensors 20a-20c have respective offset voltages, Nakagawa discloses offset removing means 30. But because the sensor and sensorless techniques are fundamentally different, one attempting to find the cause of the above-described commutation-timing problem for a sensorless motor would not have been

motivated to look at prior art directed to a sensor-type motor, let alone combine this prior art with FIG. 2 of the patent application.

In addition, because Sondermeyer discloses nothing about brushless motors, but merely discloses that a voltage drop can occur across a diode, one attempting to determine the cause of the above-described commutation-timing problem would not have been motivated to look at this reference, let alone combine it with the FIG. 2 and Nakagawa.

Consequently, because FIG. 2 does neither disclose nor suggest the cause or a solution to the above-described commutation-timing problem, and because one attempting to determine the cause of this problem for a sensorless motor would not have been motivated to even look at Nakagawa (sensor-type motor art) or Sondermeyer (unrelated to motors), one would not have been motivated to combine these references to arrive at the invention recited in claim 1.

Claims 8, 11, 16-17, and 19

These claims are patentable for reasons similar to those recited above in support of the patentability of claim 1.

Claims 2-7, 9-10, 12-15, and 18

These claims are patentable by their respective dependencies from claims 1, 8, 11, and 17.

Conclusion

In light of the foregoing and in addition to the allowed claims 2-3, claims 2-7, 9-10, 12-15, and 18 as previously pending and claims 1, 8, 11, 16-17, and 19 as amended are in condition for full allowance, which is respectfully requested.

In the event additional fees are due as a result of this amendment, payment for those fees has been enclosed in the form of a check. Should further payment be required

to cover such fees you are hereby authorized to charge such payment to Deposit Account No. 07-1897.

If the Examiner believes that a phone interview would be helpful, she is respectfully requested to contact the Applicant's attorney, Bryan Santarelli, at (425) 455-5575.

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Respectfully Submitted,

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